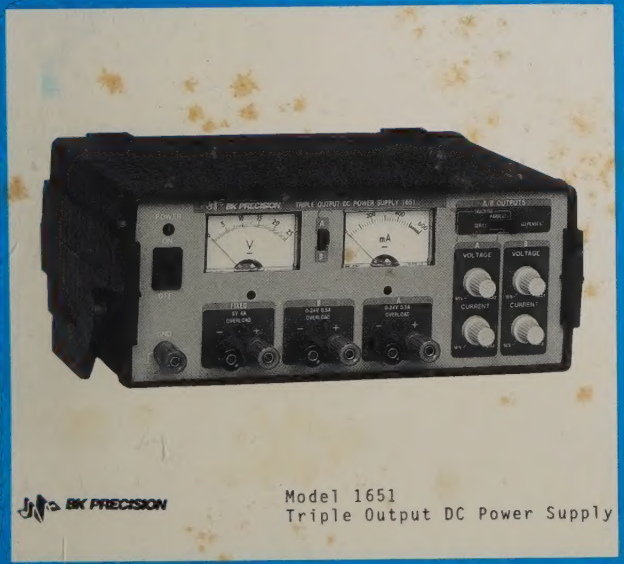
INSTRUCTION MANUAL

BK PRECISION®

MODEL 1651



Triple Output DC POWER SUPPLY

BK PRECISION®

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must sometimes be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltage poses an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. There is little danger of electrical shock from the dc output of this power supply. However, there are several other possible test conditions using this power supply that can create a high voltage shock hazard:
   a. If the equipment under test is the "hot chassis" type, a serious shock hazard exists unless the equipment is unplugged (just turning off the equipment does not remove the hazard), or the precautions of step 8 are observed.
   b. If the equipment under test is "powered up" (and that equipment uses high voltage in any of its circuits), the power supply outputs may be floated to the potential at the point of connection. Remember that high voltage may appear at unexpected points in defective equipment. Do not float the power supply output to more than 100 volts peak with respect to chassis or earth ground.
   c. If the equipment under test is "off" (and that equipment uses high voltage in any of its circuits under normal operation), discharge high-voltage capacitors before making connections or tests. Some circuits retain high voltage long after the equipment is turned off.
2. Use only a polarized 3-wire ac outlet. This assures that the power supply chassis, case, and ground terminal are connected to a good earth ground and reduces danger from electrical shock.
3. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.

(continued on back cover)

Instruction Manual
for
Model 1651

Triple Output
DC POWER SUPPLY

B+K PRECISION®

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INTRODUCTION

The **B & K-Precision** Model 1651 Triple Output DC Power Supply is a high quality, general purpose dc power source. It provides two supplies with a 0-24 volt dc output and one with a fixed 5 volt dc output. The 0-24 V supplies are adjustable and are capable of current output of 0-0.5 amp. The fixed 5 V supply has a current output of 0-4 amps, allowing it to handle extensive digital logic circuitry. Two panel mounted meters can simultaneously monitor the output current and output voltage of either of the 0-24 V supplies.

The two 0-24 volt supplies can be operated independently or in one of two tracking modes. In the series tracking mode, the "B" supply tracks the voltage of the "A" supply. In the series tracking mode the "A" and "B" supplies are connected in series, allowing a single output of 0-48 V at up to 0.5 amp. In the parallel tracking mode, the two supplies are connected in parallel, allowing a single 0-24 V output at up to 1 amp.

Both 0-24 volt supplies may be used in constant voltage or constant current applications. The crossover from constant voltage to constant current modes is smooth and automatic. LED's indicate the Constant Current mode of operation. In constant voltage applications, a current limit may be preset. When load variations cause the current to reach the preset limit, the unit then regulates output current rather than output voltage. Current limits are adjustable from 6% to 100% of maximum. In constant current applications, the maximum voltage may be preset. When load variations cause current to drop below the regulated value, the unit reverts to regulated voltage operation at the preset value.

The fixed 5 V supply is ideal for powering digital logic circuitry. The 0-4 amp capacity allows the supply to be used for large circuits. Built-in overload protection automatically limits the current output to a maximum of 4 amps. An LED indicator lights when the supply is overloaded.

The Model 1651 exhibits excellent regulation and low ripple characteristics. The circuit design incorporates a pre-regulator, which greatly reduces internal power dissipation at low output voltages.

Reverse polarity protection prevents accidental damage to the power supply from improper connection to an external voltage, and current limiting protects the equipment being powered, as well as the power supply.

The output is isolated from chassis and earth ground, which permits full flexibility of connections. When needed, the (+) or (–) polarity may be strapped to ground, or either polarity may be floated to an external voltage. Additionally, the two 0-24 volt supplies can be used as a "split supply" with two positive voltages and a common negative, two negative voltages and a common positive, or one positive, one negative, and a common. All of these configurations can be used with either matching (tracking) or differing (independent) voltages.

The features and versatility of the unit, especially the triple output and tracking features, make it an ideal general purpose power supply for engineering lab applications. It can serve as a single or multi-voltage power source, including the bias supply, for breadboard and prototype

circuits and equipment. It can provide single or simultaneously varying voltages for circuit evaluation. It can provide tracking (+) and (–) voltages for evaluating differential amplifiers. It may be used as a battery eliminator, or to power individual circuit boards or cards while removed from the system. Its output can be evaluated while powering a breadboard or prototype circuit to determine the circuit's power supply requirements. Its laboratory quality specifications will meet most engineering laboratory requirements.

The same features that make the Model 1651 a good choice for an engineering lab also make it a good choice for most other solid state electronic applications. These applications include service shops; industrial production testing of components, assemblies, and complete equipment; for school laboratories, and home use by electronic hobbyists.

FEATURES

TRIPLE OUTPUT

Operates as three separate power supplies. Each has floating output and is completely isolated from the other two.

ONE FIXED 5 V SUPPLY

0-to-4 amp fixed 5 volt supply is ideal for use with most digital logic circuitry. Adequate current capacity for extensive circuitry.

TWO 0-24 VOLT SUPPLIES

"A" and "B" supplies are continuously variable over 0-to-24 volt range. Each supply has a 0.5 amp current capacity.

UNIQUE TRACKING FEATURE

The two 0-to-24 V supplies can be operated so that the "B" supply tracks the "A" supply. Outputs can be strapped for two positive voltages with a common negative, two negative voltages with a common positive, or one positive and one negative with a neutral common.

SINGLE 0-48 V SUPPLY

Series tracking feature allows use of "A" and "B" supplies as one 0-to-48 V, 0.5 amp supply.

SINGLE 0-24 V 1 AMP SUPPLY

Parallel tracking feature allows use of "A" and "B" supplies as a 0-to-24 V supply with a 1 amp current capacity (through "A" output terminals).

CONSTANT VOLTAGE OR CONSTANT CURRENT

The "A" and "B" supplies provide regulated dc voltage output or regulated dc current output. Crossover is smooth and automatic.

METERING

Two, easy-to-read analog meters monitor output voltage and output current of the "A" and "B" supplies. Use of two meters allows simultaneous current and voltage metering when using "A" and "B" supplies in tracking or independent operation.

LABORATORY QUALITY

Excellent regulation, low ripple.

LED INDICATORS

Identify mode of operation.

PRE-REGULATOR

Limits internal dissipation for higher reliability and efficiency.

ISOLATED OUTPUT

Either polarity may be floated or grounded.

OVERLOAD PROTECTION

Fully adjustable current limiting (from 6% to 100% of maximum output current) for "A" and "B" supplies protects circuit under test and the power supply.

REVERSE POLARITY PROTECTION

Prevents damage to power supply from external voltage of reverse polarity.

HOOK-UP CABLES

Supplied with three sets of red and black hook-up leads.

SPECIFICATIONS

"A" AND "B" SUPPLIES

Output Voltage Range: 0 to 24 VDC (0 ± 100 mV).

Output Current Range: 0 to 0.5 A.

Constant Voltage Operation:

Voltage Regulation:	
Load:	≤0.01% + 3 mV.
Line (108 - 132 V):	≤0.01% + 3 mV.
Ripple and Noise:	≤2 mV rms (5 Hz to 1 MHz).
Recovery Time:	≤100 us typical.
Temp. Coefficient	
0°C TO 40°C	≤300 ppm/°C.
Tracking Error:	
No Load:	≤0.2% + 20 mV
Full Load:	≤0.2% + 100 mV

Constant Current Operation:

Adjustable Current Limits:	≤30 mA to ≥500 mA
Current Regulation:	
Load:	≤0.2% + 6 mA.
Line (108 - 132 V):	≤0.2% + 3 mA.
Ripple Current and Noise:	≤3 mA rms.

Metering ("A" & "B" only):

Voltmeter:	
Range:	0 to 25 V
Accuracy:	≤2.5% of Full Scale.
Ammeter:	
Range:	0 to 600 mA
Accuracy:	≤2.5% of Full Scale.

FIXED 5 V SUPPLY

Output Voltage:	5 V ± 100 mV.
Maximum Current:	≥4 A.

SPECIFICATIONS

Load Regulation:	≤10 mV.
Line Regulation 108 - 132 V:	≤5 mV.
Ripple And Noise:	≤2 mV rms (5 Hz to 1 MHz).
Overvoltage Protection Threshold:	5.7 to 6.5 V

GENERAL

Power Requirements:	100/120/220/240 VAC ± 10%, 50/60 Hz.
Power Consumption:	165 VA.
Protection:	Reverse polarity, overvoltage and current limiting.
Temperature Range & Humidity:	
Operation:	0°C to 40°C <80% R.H.
Storage:	-20°C to 60°C <70% R.H.
Dimensions (H x W x D):	100 x 240 x 190 mm (3.9 x 9.4 x 7.5″).
Weight:	4.8 kg (10.6 lbs).
Accessories Supplied:	Hook-Up Cables, 3 pair (Black & Red). Power Cord. Spare Fuse. Instruction Manual

CONTROLS AND INDICATORS

1. **POWER Switch.** Turns power on and off.
2. **Power ON light.** Red LED lights to indicate a power on condition.
3. **GND Terminal (Green).** Earth and Chassis Ground.
4. **A/B Metering Switch.** Selects simultaneous Voltage & Current metering for the **"A"** or **"B"** supplies. When in the **A** position, the **V** and **mA** meters are connected to the **"A"** supply. When in the **B** position, the **V** and **mA** meters are connected to the **"B"** supply.
5. **V Meter.** Indicates voltage on the **"A"** or **"B"** supply depending on the position of the **A/B Metering** switch.
6. **mA Meter.** Indicates current on the **"A"** or **"B"** supply depending on the position of the **A/B Metering** switch.
7. **Zero Adjusts.** Mechanical zero adjusts for the **V & mA Meters** thru the front panel with a slotted screwdriver.
8. **TRACKING / INDEPENDENT Mode Switch:** Three Position switch that selects **INDEPENDENT** mode, **PARALLEL TRACKING** mode, or **SERIES TRACKING** mode of the **"A"** and **"B"** supplies as follows:
   a. When the switch is in the right position, the unit is in the **INDEPENDENT** mode and the **"A"** and **"B"** power supplies are completely independent from one another.
   b. When the switch is in the middle position, the unit is in the **PARALLEL TRACKING** mode. In this mode the **"A"** and **"B"** supplies are wired together in parallel and both the maximum current and voltage are set using the **"A"** controls. The **"A"** and **"B"** outputs can be used as two individual (but tracking) power supplies or just the **"A"** output can be used as a 0-to-24 volt supply with a 1 A capability.
   c. When the switch is in the left position, the unit is in the **SERIES TRACKING** mode. In this mode, maximum voltage of both supplies is set using the **"A" VOLTAGE** controls (voltage at output terminals of the **"B"** supply tracks the voltage at the output terminals of the **"A"** supply). Also, in this mode of operation the positive terminal (red) of the **"B"** supply is internally connected to the negative terminal (black) of the **"A"** supply. This allows the two supplies to be used as one 0-to-48 volt supply.

"A" SUPPLY CONTROLS AND INDICATORS

9. **VOLTAGE Control.** Adjusts the output voltage of the **"A"** supply. Also functions as the adjustment control for the maximum output voltage of the **"B"** supply when either parallel or series tracking mode is selected. Voltage can be read from the **V Meter** when the **A Metering** mode is selected.

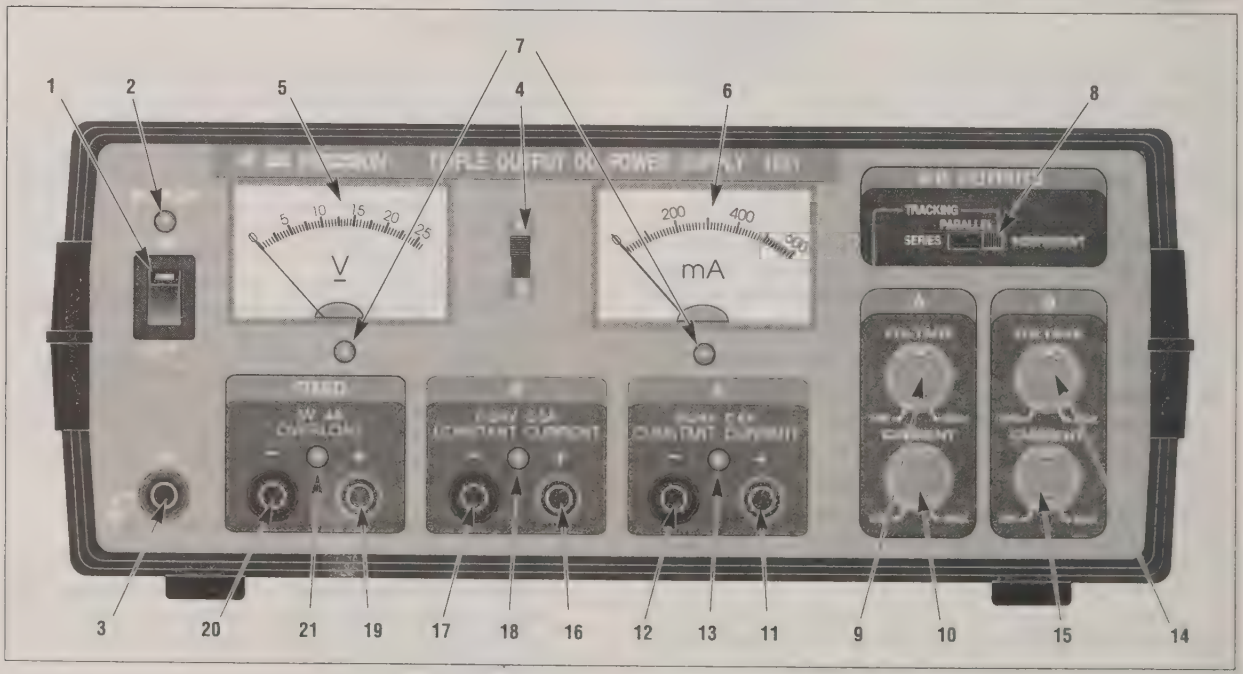

Figure 1. Front panel controls and indicators.

10. **CURRENT Control.** Adjusts the current limit of **"A"** supply in constant voltage mode. Adjusts the constant current value of **"A"** supply in constant current mode. Adjusts the constant current value of the **"B"** supply when either **SERIES or PARALLEL TRACKING** is selected. Current can be read from the **mA Meter** when the **A Metering** mode is selected.

11. **"+" Terminal (Red).** Positive polarity output terminal for the **"A"** supply. Also serves as the positive polarity terminal for 0-to-24V, 1A parallel tracking and 0-to-48V, 0.5A series tracking operation.

12. **"–" Terminal (Black).** Negative polarity output terminal for the **"A"** supply. Also serves as the negative polarity terminal for 0-to-24V, 1A parallel tracking operation. In series tracking operation, this terminal is internally tied to the (+) positive terminal of the **"B"** supply.

13. **CONSTANT CURRENT Indicator.**

    a. Red LED lights when **"A"** supply is in the Constant Current mode. The Power Supply regulates the output current at the value set by the **"A" CURRENT** control. In the Parallel Tracking mode, when this indicator is lit, both the **"A"** and **"B"** supplies are in the Constant Current mode.

    b. When the LED is off, the **"A"** supply is in the Constant Voltage mode. The Power Supply regulates the output voltage at the value set by the **"A" VOLTAGE** controls. In either the Series or Parallel Tracking mode, when this indicator is off, both the **"A"** and **"B"** supplies are in the Constant Voltage mode.

"B" SUPPLY CONTROLS AND INDICATORS

14. **VOLTAGE Control.** Adjusts the output voltage of the **"B"** supply when the **INDEPENDENT** mode is selected. Voltage can be read on the **V Meter** when the **B Metering** mode is selected. Control is disabled when **TRACKING** mode is selected.

15. **CURRENT Control.** Adjusts current limit of **"B"** supply in constant voltage mode. Adjusts constant current value of **"B"** supply in constant current mode. Current can be read from the **mA Meter** when the current **mA Metering** mode is selected. Control is disabled when **TRACKING** mode is selected.

16. **"+" Terminal (Red).** Positive polarity output terminal for the **"B"** supply. In series tracking operation, this terminal is connected to the negative terminal of the **"A"** supply.

17. **"–" Terminal (Black).** Negative polarity output terminal for the **"B"** supply. Also serves as the negative polarity terminal for 0-to-48 V series tracking operation.

18. **CONSTANT CURRENT Indicator.**

    a. Red LED lights when **"B"** supply is in the Constant Current mode. The Power Supply regulates the output current at the value set by the **"B" CURRENT** control when in the **INDEPENDENT** mode.

    b. When LED is off, the **"B"** supply is in the Constant Voltage mode.

FIXED 5 V SUPPLY TERMINALS AND INDICATOR

19. **"+" Terminal (Red).** Positive polarity output terminal for FIXED 5 V supply.

20. **"–" Terminal (Black).** Negative polarity output terminal for FIXED 5 V supply.

21. **OVERLOAD Indicator.** Lights when load on FIXED 5 Volt supply becomes too large.

REAR PANEL CONTROLS

22. **Fuse.**

23. **Line Cord Receptacle.**

24. **LINE VOLTAGE SELECT Switches.** Combination settings allow Universal Power Operation; 100,120,220,240 VAC, 50/60 Hz.

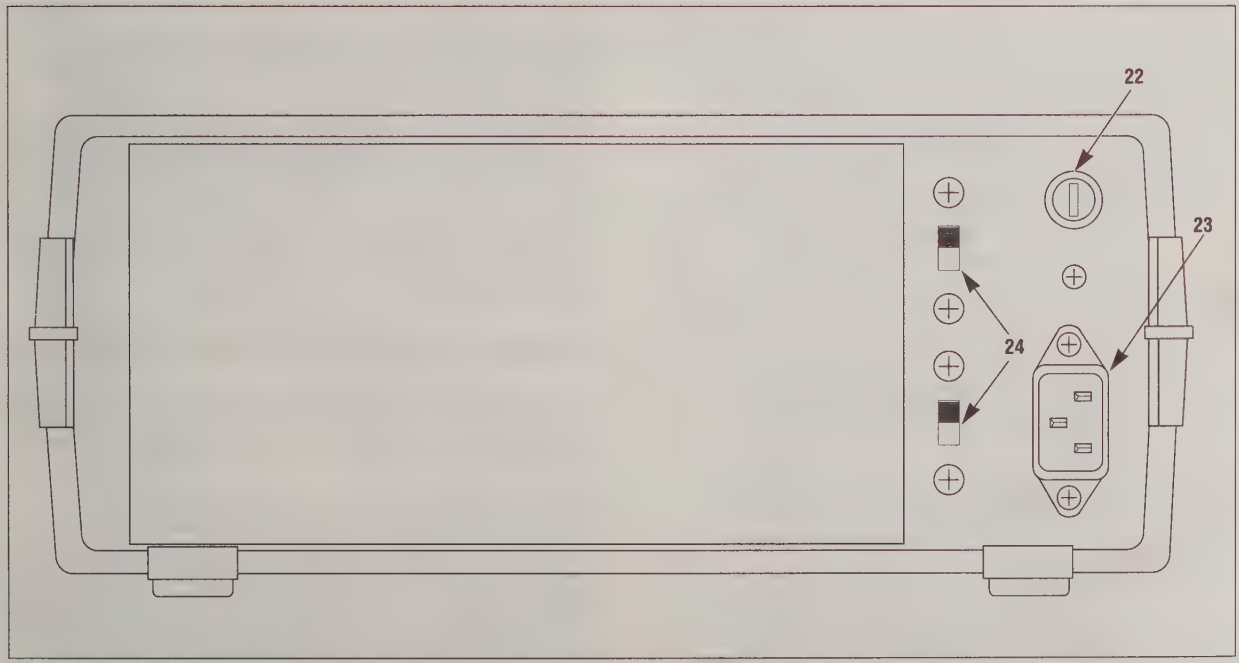

Figure 2. Rear panel controls.

OPERATING INSTRUCTIONS

SAFETY PRECAUTIONS

CAUTION

Avoid contacting the heat sink at the rear of the power supply. When the unit is providing large amounts of current at any or all of its outputs, the heat sink can become very hot. Contacting the heat sink when it is hot could result in skin burns or damage to the equipment in contact with it.

Use only a polarized 3-wire ac outlet. This assures that the power supply chassis, case, and ground terminal are connected to a good earth ground and reduces danger from electrical shock.

There may be great danger of electrical shock if the power supply output is connected to an external high voltage. Some equipment being powered may contain high voltage and present a shock hazard. Observe caution. If the power supply output is floated (referenced to a voltage rather than earth ground) turn off the power supply and the equipment under test when making connections. Never float the power supply to a potential greater than 100 volts peak with respect to earth ground.

EQUIPMENT PRECAUTIONS

Avoid using the power supply in ambient temperatures above +40°C. Always allow sufficient air space around the heat sink at the rear of the power supply for effective radiation to prevent internal heat build-up.

Although the power supply is protected against reverse polarity damage, the circuit being powered may not include such protection. Always carefully observe polarity; incorrect polarity may damage the equipment under test.

Do not exceed the voltage rating of the circuit being powered. Many transistors and integrated circuits will not withstand voltage of 24 volts.

There is no need to worry about voltage spikes or overshoot damaging the equipment under test. The voltage between the output terminals of the power supply never exceeds the preset value as the **POWER** switch is turned on or off.

INDEPENDENT USE OF "A" OR "B" SUPPLY

The **"A"** and **"B"** supplies each provide a 0-to-24 volt output at up to 0.5 amps. This procedure covers the use of the **"A"** and **"B"** supplies only when they are used independently from one another. When used in the **INDEPENDENT** operating mode, the operating controls of the two power supplies are completely independent and either supply can be used individually or both can be used simultaneously. Basic operation is covered here, the **"A"** supply being used as an example. Several variations are covered in the APPLICATIONS section of this manual.

Hook-up

1. Set the **TRACKING/INDEPENDENT Mode Switch** to the right position so that the power supply is in the **INDEPENDENT** operating mode.
2. Set the **A/B Metering** selection switch to the **A** (up) position to monitor the **"A"** supply.
3. Turn off the power supply and the equipment to be powered during hook-up.
4. Connect the positive polarity of the device being powered to the red (+) terminal of the power supply.
5. Connect the negative polarity of the device being powered to the black (–) terminal of the power supply.
6. Fig. 3 illustrates the grounding possibilities when used in the **INDEPENDENT** mode.
   a. If the negative polarity of the equipment or circuit being powered is also the chassis or common, it may be grounded to earth by connecting the black (–) terminal to the green (**GND**) terminal as shown in Fig. 3A.
   b. Similarly, the positive polarity can be grounded by connecting the red (+) terminal to the green (**GND**) terminal as shown in Fig. 3B.
   c. If an earth ground reference is not required, the configuration of Fig. 3C may be used. The scheme in Fig. 3C should also be used where it is not known whether the chassis is common with either the positive or negative polarity.
   d. If the chassis or common of the equipment being powered is separate from both the positive and negative polarity power inputs, use the connection shown in Fig. 3D.
6. Observe proper polarity. If the circuit being powered is not equipped with reverse polarity protection, damage to the circuit can result from reverse polarity. Use color coded hook-up leads, such as the sets supplied with the power supply, for convenience in identifying polarity, red for (+) and black for (–).
7. Make sure that the hook-up leads offer sufficient current capability and low resistance between the power supply and the circuits being powered. The hook-up leads supplied with the power supply are rated for 4 amps.

Typical Constant Voltage Operation

1. Before connecting the device to be powered to the power supply, determine the maximum safe load current for the device to be powered and set the current limit value (see "Setting Current Limit" procedure in this section).
2. Set the **A/B Meter** selection switch to the **A** (up) position to monitor the **"A"** supply.
3. Set **VOLTAGE** control to minimum (fully counterclockwise).
4. Turn off power supply and connect it to the device to be powered (see "Hook-Up" procedure in this section).
5. Turn on **POWER** switch. The **CONSTANT CURRENT** indicator should NOT light.
6. Increase the **VOLTAGE** setting until the **V**olt meter reads the desired value.
7. The load current is read directly on the **mA** meter.

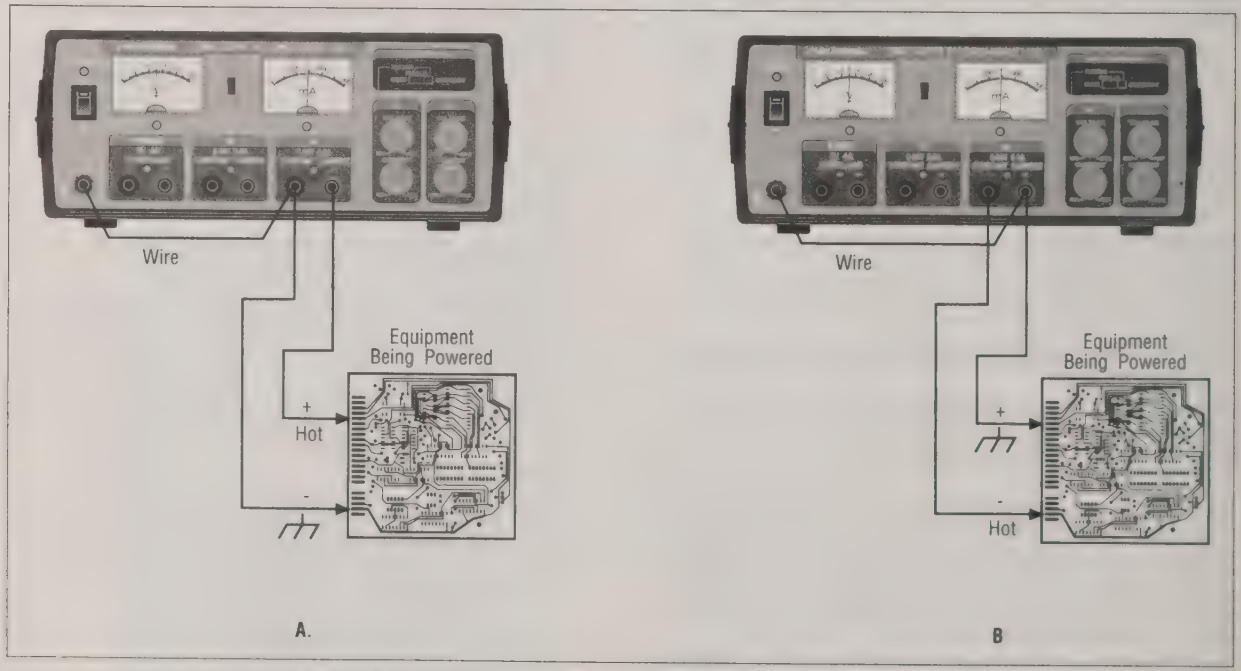

Figure 3. Independent operation grounding possibilities (sheet 1 of 2).

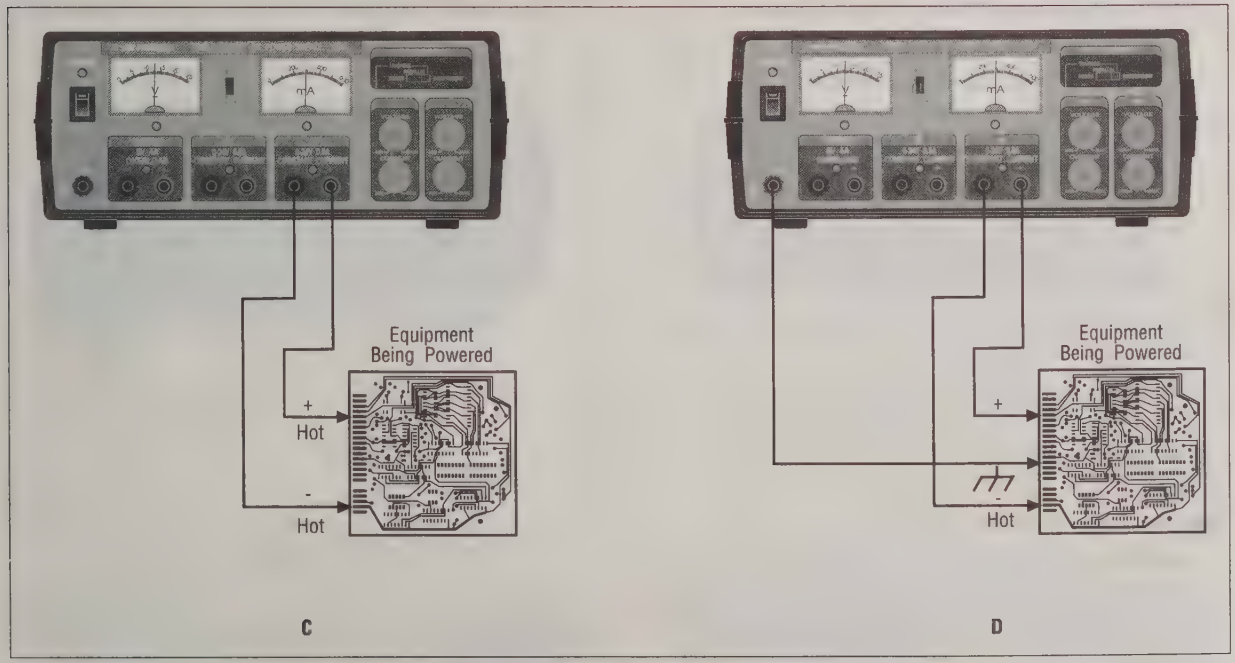

Figure 3. Independent operation grounding possibilities (sheet 2 of 2).

8. If the load current exceeds the preset current limit, the **CONSTANT CURRENT** indicator will light. In this case, the power supply automatically switches to the constant current mode and further rotation of the **VOLTAGE** control will not increase the output voltage.

Setting Current Limit

1. Determine the maximum safe current for the device to be powered.
2. Temporarily short the (+) and (–) terminals of the power supply together with a test lead.
3. Rotate the **VOLTAGE** control away from zero sufficiently for the **CONSTANT CURRENT** indicator to light.
4. Adjust the **CURRENT** control for the desired current limit. Read the current value on the **mA** meter.
5. The current limit (overload protection) has now been preset. Do not change the **CURRENT** control setting after this step.
6. Remove the short between the (+) and (–) terminals and hook up for constant voltage operation.

Typical Constant Current Operation

1. Before connecting the device to be powered to the power supply, determine the maximum safe voltage to be applied, set the **A/B Meter** selection switch to the **A** (up) position, and set the **VOLTAGE** control to obtain that voltage reading on the Volt meter.
2. Determine the desired constant current value.
3. Set the **CURRENT** control to minimum (fully counterclockwise).

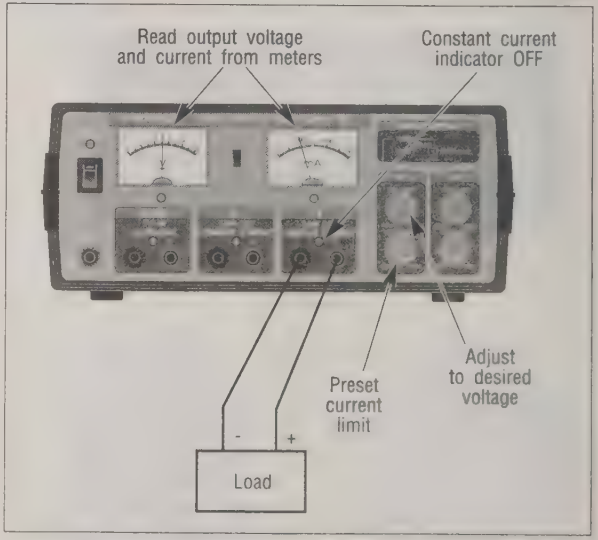

Figure 4. Typical constant voltage operation.

4. Turn off the power supply and connect it to the device to be powered.
5. Turn on the power supply. The **CONSTANT CURRENT** indicator should light.
6. The current can be read directly on the **mA** meter.

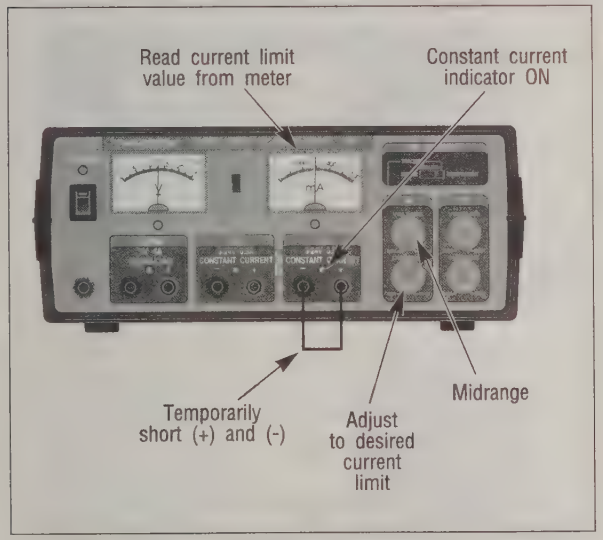
Read current limit value from meter
Constant current indicator ON
Temporarily short (+) and (-)
Adjust to desired current limit
Midrange

Figure 5. Setting current limit.

7. Increase the **CURRENT** control setting until the desired constant current value is read on the display, or set the current limit in advance (before connecting the load) as prescribed earlier in the "Setting Current Limit" procedure

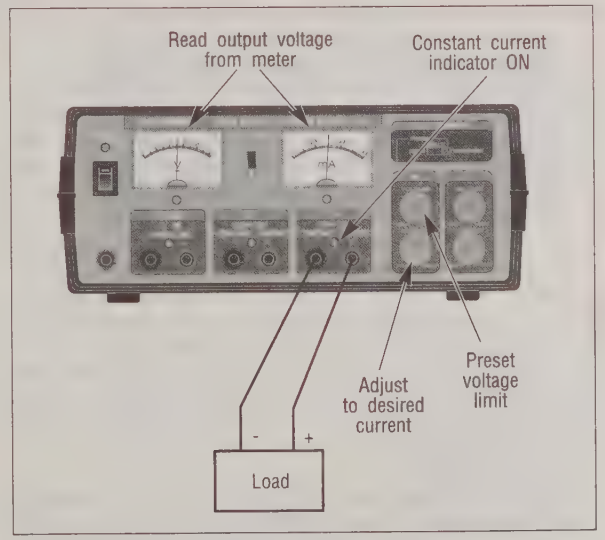

Figure 6. Typical constant current operation.

8. If the load current drops below the constant current value, the **CONSTANT CURRENT** indicator will go off. In this case, the power supply automatically switches to the constant voltage mode, and further rotation of the **CURRENT** control will not increase the output current.

Constant Voltage/Constant Current Characteristic

The working characteristic of this power supply is called a constant voltage/constant current automatic crossover type. This permits continuous transition from constant current to constant voltage modes in response to the load change. The intersection of constant voltage and constant current modes is called the crossover point. Fig. 7 shows the relationship between this crossover point and the load.

For example, if the load is such that the power supply is operating in the constant voltage mode, a regulated output voltage is provided. The output voltage remains constant as the load increases, up until the point where the preset current limit is reached. At that point, the output current becomes constant and the output voltage drops in proportion to further increases in load. The crossover point is indicated by the front panel LED indicators. The crossover point is reached when the **CONSTANT CURRENT** indicator comes on.

Similarly, crossover from the constant current to the constant voltage mode automatically occurs from a decrease in load. A good example of this would be seen when charging a 12-volt battery. Initially, the open circuit voltage of the power supply may be preset for 13.8 volts. A low battery will place a heavy load on the supply and it will operate in the constant current mode, which may be adjusted for a 0.5 amp charging rate. As the battery becomes charged, and its voltage approaches 13.8 volts, its load decreases to the point where it no longer demands the full 0.5 amp charging rate. This is the crossover point where the power supply goes into the constant voltage mode.

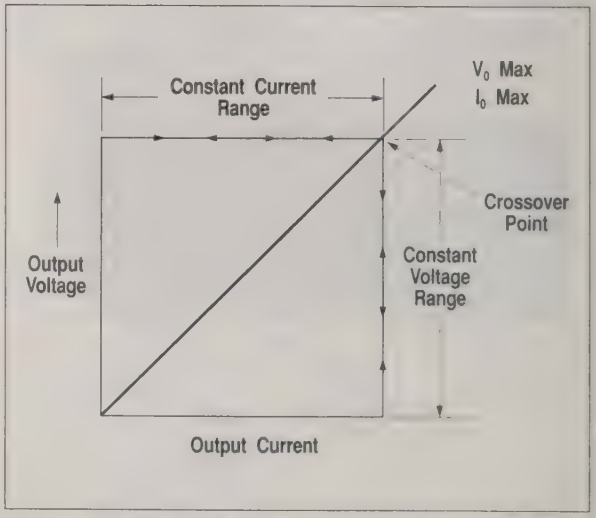

Figure 7. Constant voltage/constant current characteristic.

SERIES TRACKING OPERATION

When the series tracking mode of operation is selected, the positive (red) terminal of the **"B"** supply output is internally connected to the negative (black) terminal of the **"A"** supply. This allows the power supply to be used as a single 0-to-48 volt power supply simply by using

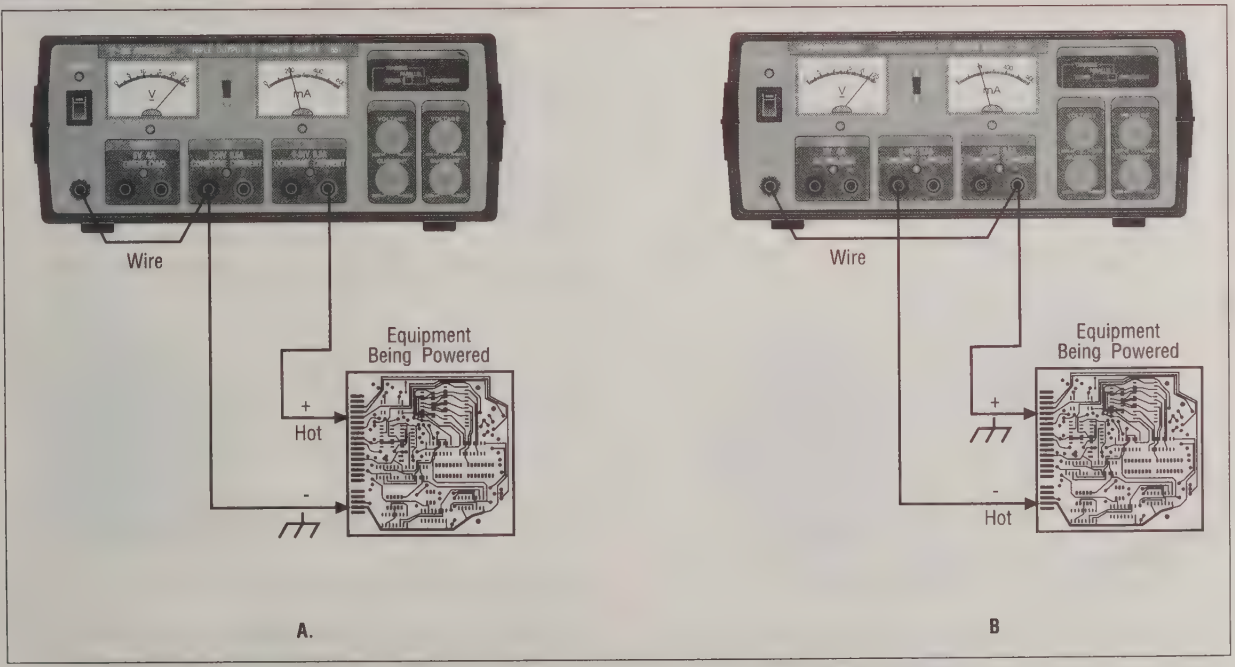

Figure 8. Series tracking (0-to-48 V) operation grounding possibilities (sheet 1 of 3).

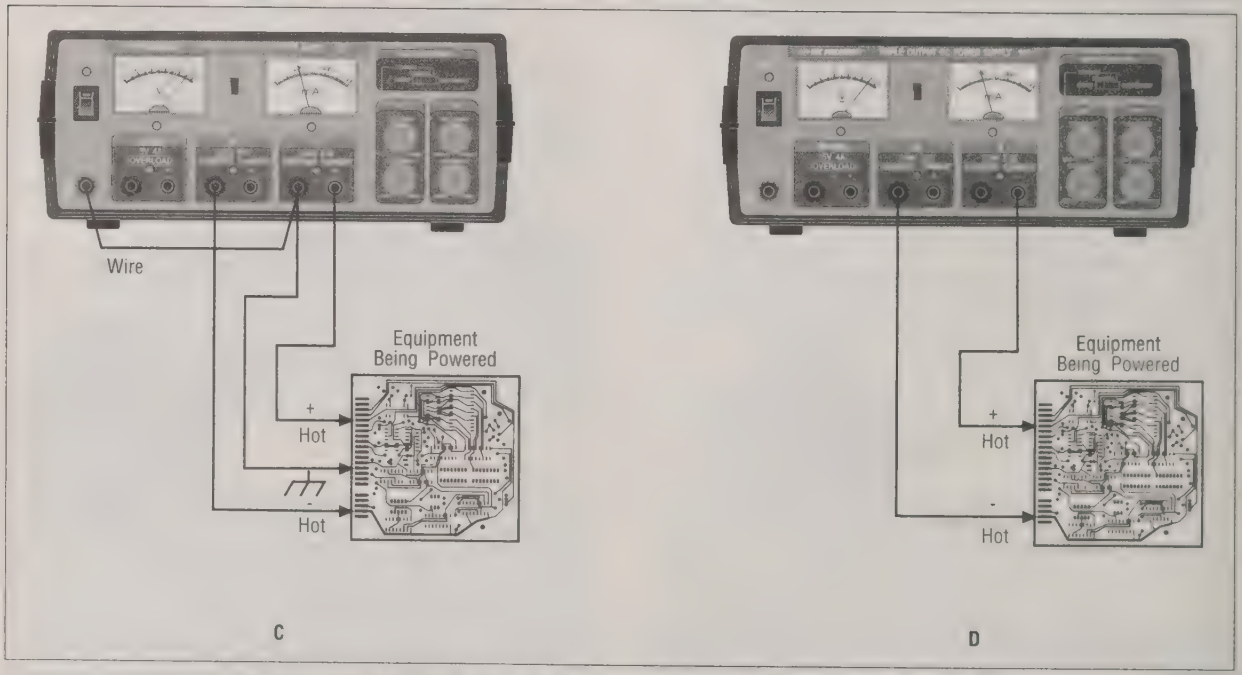

Figure 8. Series tracking (0-to-48 V) operation grounding possibilities (sheet 2 of 3).

the negative (black) terminal of the **"B"** supply and the positive (red) terminal of the **"A"** supply.

In the series tracking mode, the maximum output voltage of both the **"A"** and **"B"** supplies can be simultaneously varied with one control. The maximum **"B"** supply voltage is automatically set to the same value as the **"A"** supply by using the **"A" VOLTAGE** control.

The output voltage (across the two supplies) is actually double the Volt meter reading. The actual output current would be the value read from the **mA** meter (since the two supplies are wired in in series, current flowing through each supply must be equal).

1. Set the power supplies to the **TRACKING SERIES** mode by setting the **TRACKING/INDEPENDENT** switch to the **SERIES** (left) position.
2. Set the **A/B Metering** switch to the **A** (up) position.
3. The **"B" VOLTAGE and CURRENT** controls are disabled: turn both to their minimum positions. The maximum current is set using the **"A" CURRENT** control. Follow the instructions for "Setting Current Limit" (INDEPENDENT USE OF "A" OR "B" SUPPLY section of this manual) using the **"A" CURRENT** control.
4. Adjust the output voltage to the desired level using the **"A" VOLTAGE** control (remember that the actual output voltage is double the reading on the Volt meter).
5. Turn off the power supply and the equipment to be powered during hook-up.
6. Connect the positive polarity of the device being powered to the red (+) terminal of the **"A"** power supply.
7. Connect the negative polarity of the device being powered to the black (–) terminal of the **"B"** power supply.

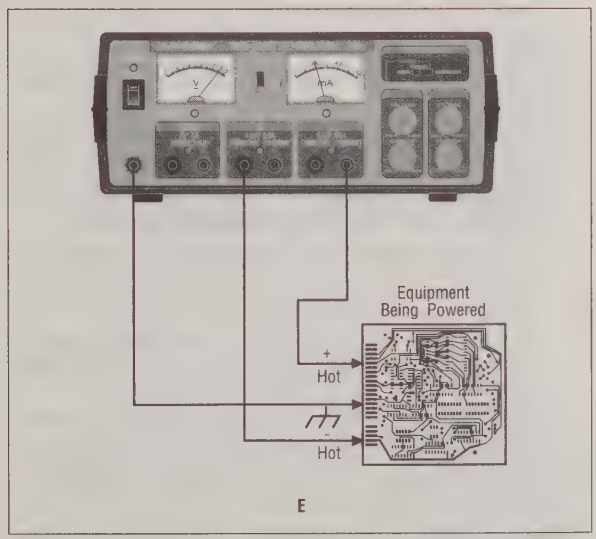

Figure 8. Series tracking (0-to-48 V) operation grounding possibilities (sheet 3 of 3).

8. Fig. 8 illustrates the grounding possibilities when the unit is used as a 0-to-48 volt supply.
   a. If the negative polarity of the equipment or circuit being powered is also the chassis or common, it may be grounded to earth by

connecting the black (–) terminal of the **"B"** supply to the green (**GND**) terminal as shown in Fig. 8A.

b. Similarly, the positive polarity can be grounded by connecting the red (+) terminal of the **"A"** supply to the green (**GND**) terminal as shown in Fig. 8B.

c. If "split supply" operation is desired, a positive and negative voltage with a center ground can be acheived by connecting the black (–) terminal of the **"A"** supply to the green (**GND**) terminal as shown in Fig. 8C. See the APPLICATIONS section of this manual for more information on "split supply" operation.

d. If an earth ground reference is not required, the configuration of Fig. 8D may be used. The scheme in Fig. 8D should also be used where it is not known whether the chassis is common with either the positive or negative polarity.

e. If the chassis or common of the equipment being powered is separate from both the positive and negative polarity power inputs, use the connection shown in Fig. 8E.

9. Observe proper polarity. If the circuit being powered is not equipped with reverse polarity protection, damage to the circuit can result from reverse polarity. Use color coded hook-up leads, such as the sets supplied with the power supply, for convenience in identifying polarity, red for (+) and black for (–).

10. Make sure that the hook-up leads offer sufficient current capability and low resistance between the power supply and the circuits being powered. The hook-up leads supplied with the power supply are rated for 4 amps.

PARALLEL TRACKING OPERATION

In the parallel tracking mode of operation, both supplies are strapped together (in parallel). This allows for a 0-24 V supply with a 1 amp current capability. Only the **"A"** output terminals are used for parallel tracking operation. In the parallel tracking mode, the **"B"** supply output voltage and current track the **"A"** supply output voltage and current.

1. Set the power supplies to the **TRACKING PARALLEL** mode by setting the **TRACKING/INDEPENDENT** switch to the **PARALLEL** (middle) position.

2. Set the **A/B Metering** switch to the **A** (up) position. Output voltage will be read from the **Volt** meter. Output current is exactly **DOUBLE** the value read from the **mA** meter (because each supply is providing the same amount of current).

3. The **"B" VOLTAGE and CURRENT** controls are disabled; turn both to their minimum positions. The maximum current and voltage are set using the **"A"** controls. Using the "A" supply output jacks, follow the instructions for "Setting Current Limit" (INDEPENDENT USE OF "A" OR "B" SUPPLY paragraph of this section). Remember that the actual current output at the "A" supply output jacks is double the reading on the **mA** meter.

4. Adjust the output voltage to the desired level using the **"A" VOLTAGE** control.

5. Turn off the power supply and the equipment to be powered during hook-up.

6. Connect the positive polarity of the device being powered to the red (+) terminal of the **"A"** power supply.

7. Connect the negative polarity of the device being powered to the black (–) terminal of the **"A"** power supply.

8. Fig. 9 illustrates the grounding possibilities when used in the **TRACKING PARALLEL** mode.

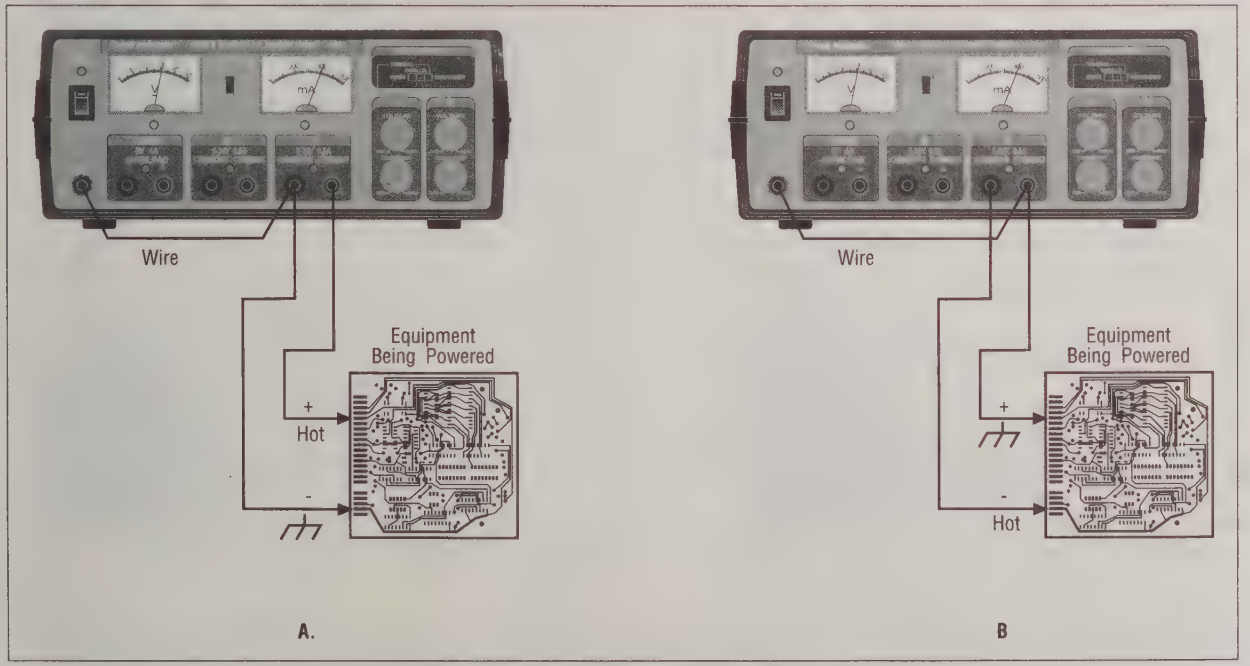

Figure 9. Parallel tracking operation grounding possibilities (sheet 1 of 2).

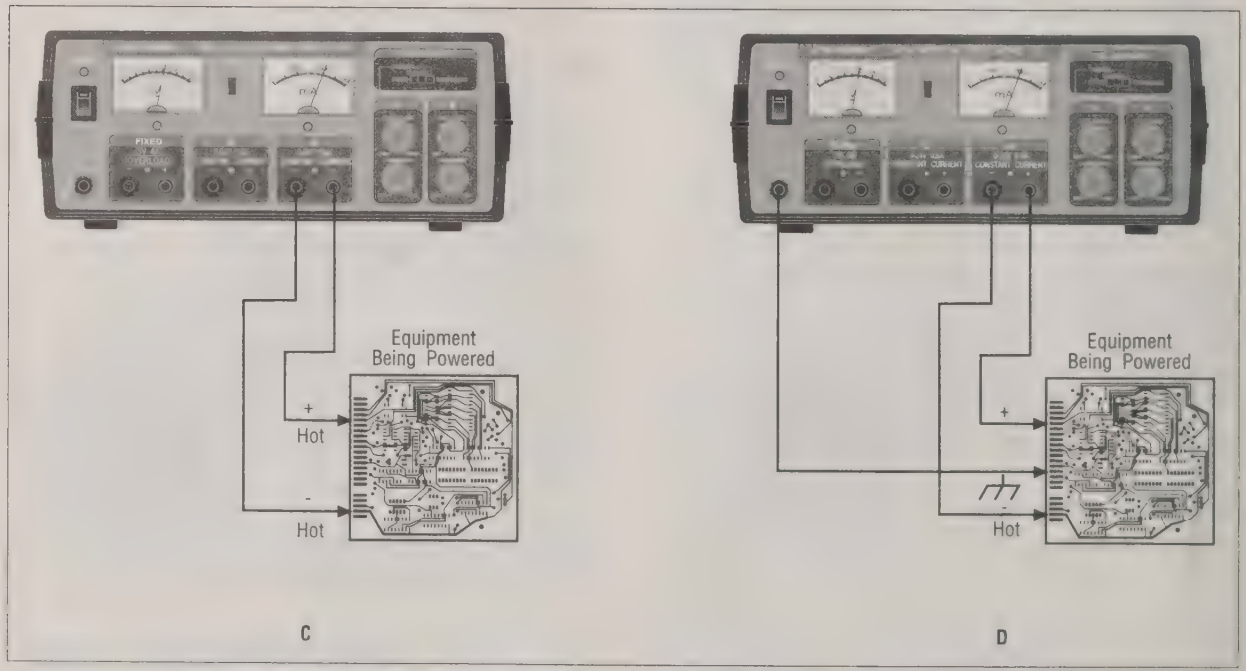

Figure 9. Parallel tracking operation grounding possibilities (sheet 2 of 2).

a. If the negative polarity of the equipment or circuit being powered is also the chassis or common, it may be grounded to earth by connecting the black (–) terminal to the green (**GND**) terminal as shown in Fig. 9A.

b. Similarly, the positive polarity can be grounded by connecting the red (+) terminal to the green (**GND**) terminal as shown in Fig. 9B.

c. If an earth ground reference is not required, the configuration of Fig. 9C may be used. The scheme in Fig. 9C should also be used where it is not known whether the chassis is common with either the positive or negative polarity.

d. If the chassis or common of the equipment being powered is separate from both the positive and negative polarity power inputs, use the connection shown in Fig. 9D.

9. Observe proper polarity. If the circuit being powered is not equipped with reverse polarity protection, damage to the circuit can result from reverse polarity. Use color coded hook-up leads, such as the sets supplied with the power supply, for convenience in identifying polarity, red for (+) and black for (–).

10. Make sure that the hook-up leads offer sufficient current capability and low resistance between the power supply and the circuits being powered. The hook-up leads supplied with the power supply are rated for 4 amps.

FIXED 5 V POWER SUPPLY OPERATION

The **FIXED 5 V** supply provides a 4 amp current capacity. The supply is ideal for use with TTL circuits.

1. Turn off the power supply and the equipment to be powered during hook-up.

2. Connect the positive polarity of the device being powered to the red (+) terminal of the **FIXED 5 V** supply.

3. Connect the negative polarity of the device being powered to the black (–) terminal of the **FIXED 5 V** supply.

4. Fig. 10 illustrates the grounding possibilities of the **FIXED 5 V** supply.

   a. If the negative polarity of the equipment or circuit being powered is also the chassis or common, it may be grounded to earth by connecting the black (–) terminal to the green (**GND**) terminal as shown in Fig. 10A.

   b. Similarly, the positive polarity can be grounded by connecting the red (+) terminal and the green (**GND**) terminal as shown in Fig. 10B.

   c. If an earth ground reference is not required, the configuration of Fig. 10C may be used. The scheme in Fig. 10C should also be used where it is not known whether the chassis is common with either the positive or negative polarity.

   d. If the chassis or common of the equipment being powered is separate from both the positive and negative polarity power inputs, use the connection shown in Fig. 10D.

5. Observe proper polarity. If the circuit being powered is not equipped with reverse polarity protection, damage to the circuit can result from reverse polarity. Use color coded hook-up leads, such as the sets supplied with the power supply, for convenience in identifying polarity, red for (+) and black for (–).

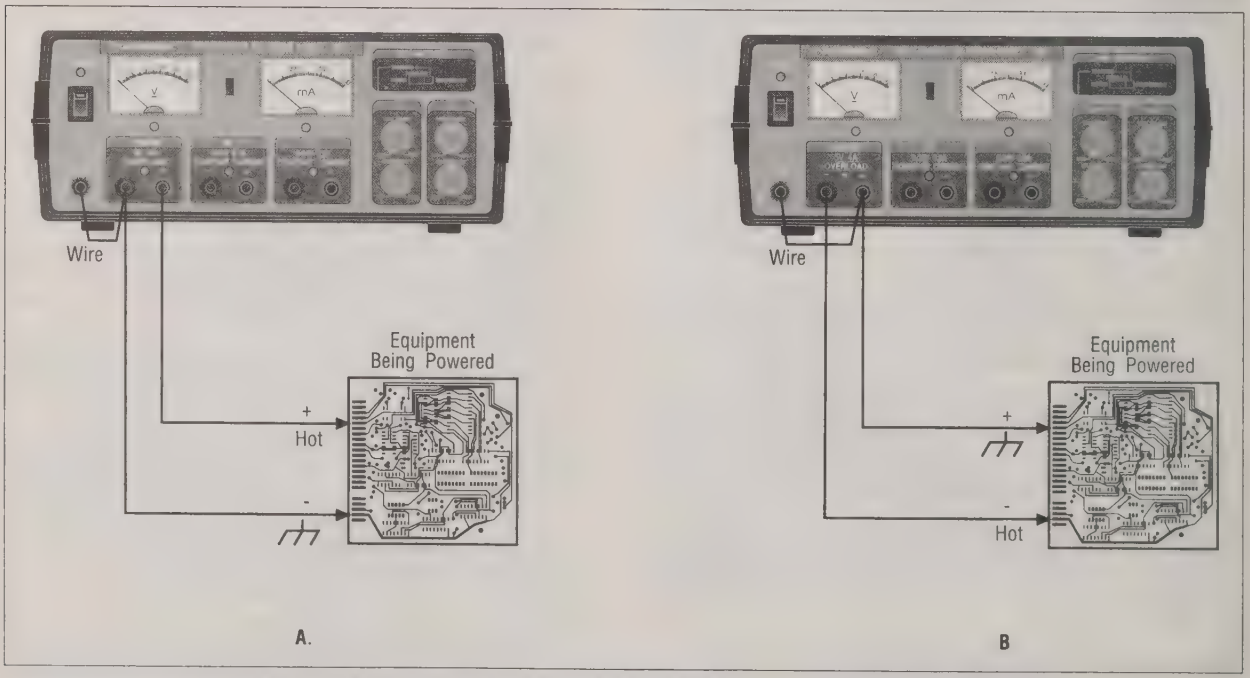

Figure 10. Grounding possibilities for fixed 5 V power supply (sheet 1 of 2).

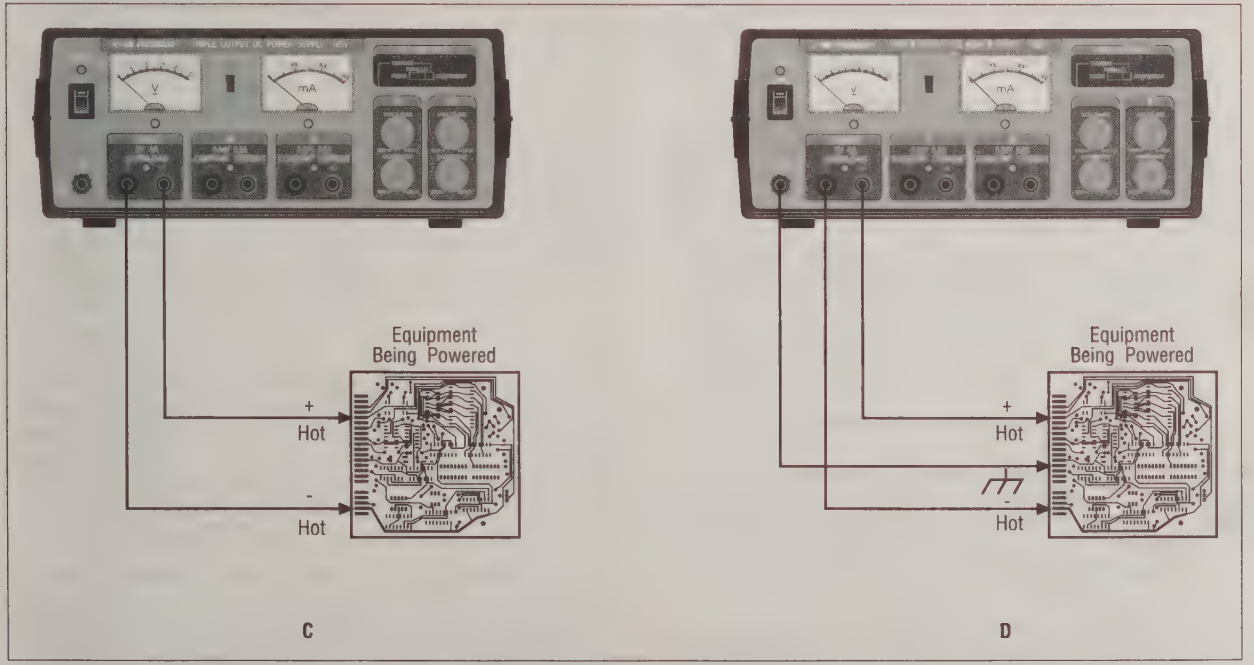

Figure 10. Grounding possibilities for fixed 5 V power supply (sheet 2 of 2).

6. Make sure that the hook-up leads offer sufficient current capability and low resistance between the power supply and the circuits being powered. The hook-up leads supplied with the power supply are rated for 4 amps.

7. If the red **OVERLOAD** indicator lights, too much load has been placed on the supply. This will cause voltage and current to drop and prevent proper operation of the **FIXED 5 V** supply. To correct this situation, the load on the supply must be decreased so that no more than 4 amps of current are required.

NOTE

If decreasing the load does not cause the overload indicator to turn off, the overvoltage protection circuitry has turned on. In order to return the supply to normal operation, the output voltage must be decreased (or the external voltage source must be removed) **and the power must be momentarily shut off.**

APPLICATIONS

GENERAL

The Model 1651 power supply has a very wide variety of applications in electrical and electronics servicing, engineering laboratories, manufacturing and testing facilities, schools, and by home hobbyists. The "A" and "B" power supply outputs are fully adjustable from 0-to-24 volts and 0-to-0.5 amps and the FIXED 5 V supply has a current capability of 0-to-4 amps. This flexibility makes it suitable for most applications requiring a dc power source.

ELECTRONICS SERVICING

Most electronics troubleshooting and repair is performed on a test bench. This power supply can provide the dc power source to operate a module or circuit board on the test bench when it is removed from its parent equipment. It can be used to power portable, battery-operated equipment and check the effect of low battery voltage. It can power some vehicular equipment such as tape players, auto sound systems, CB radios, etc. on the test bench. Parallel tracking supplies up to 1 amp.

Most automobiles and other vechicles use 12-volt electrical systems. Although the electrical system is normally referred to as a 12-volt system, actual battery voltage when fully charged is approximately 13.8 volts. The power supply may be set to 13.8 volts for servicing equipment from vehicles with 12-volt electrical systems. Some trucks use a 24-volt electrical system; bench testing of equipment from these systems should be performed at approximately 28 volts.

Some servicing applications require the injection of a variable dc voltage for certain tests, such as checking the effect of AGC bias in a television receiver. This requires an isolated dc power supply, such as the Model 1651. The equipment being tested may contain its own power supply and operate from ac power. A dc voltage may already be present in the circuit. One polarity of the power supply output is floated to an appropriate point in the circuit, such as the emitter of a transistor. The other polarity of the power supply output is then applied to another point in the circuit, such as the base of that transistor. Varying the power supply voltage then varies the dc bias on the stage, and the effects may be noted. A series limiting resistor is often used to protect the circuits from overdissipation.

ELECTRONICS MANUFACTURING

In electronics manufacturing facilities, the power supply is often used as a dc power source while testing and adjusting modules, subassemblies, and complete units in the production and assembly area or in the quality control area. The instrument can be used in incoming inspection as a dc power source for testing purchased components and subassemblies.

This power supply is particularly well suited for manufacturing applications because of its ease of operation and its continuous duty rating. When load current or total power dissipation are among the main characteristics to be measured, the total load current and voltage are simultaneously displayed on the panel meters. The current limit can be

set so that all units which do not meet the load current specification will cause the **CONSTANT CURRENT** indicator to light, and the unit can be rejected.

ELECTRONICS DESIGN LAB

The technician or engineer working in an engineering laboratory requires a dc power supply to power breadboard and prototype circuits. This power supply is ideal because it simultaneously monitors output current and voltage, limits current to protect the circuit, is adjustable over a wide range, and has excellent regulation and very low ripple.

Use of the instrument in an engineering laboratory is very similar to that described for servicing electronics equipment and modules, except that lower currents may be prevalent when powering individual circuits. The current limiting feature is very valuable in this application because it can protect unproven circuits from damage.

ELECTRONICS EDUCATION

The student in an electronics curriculum may use the power supply for powering equipment and circuits as previously described for all other applications. In addition, the power supply can be used in the classroom laboratory to conduct experiments in fundamental electronics. In learning Ohm's law, for example, the relationships of resistance, current, and voltage are easily demonstrated by the use of a power supply.

BATTERY CHARGING

The power supply can be used as a battery charger to restore the charge in rechargeable batteries such as lead-acid, nickel-cadmium, and some alkaline types. Refer to the battery manufacturer's charging specifications for proper voltage and current settings. Charging information is sometimes printed on the batteries. Battery charging, at least initially, requires the constant current mode of operation. Before connecting the power supply to the battery, preset the **VOLTAGE** controls to the fully charged terminal voltage specified by the battery manufacturer. Turn off the power supply while connecting the battery. Observe proper polarity and connect as for constant current operation. Adjust the **CURRENT** control for the maximum charging current specified by the battery manufacturer. (If the maximum charging current is greater than the power supply's maximum load current, set the **CURRENT** control to maximum). The **CONSTANT CURRENT** indicator will light and the battery will charge at the preset current limit. As the battery approaches full charge, its terminal voltage will approach that of the power supply output and the charging current will taper off. The power supply may automatically switch to constant voltage operation. When this occurs, the power supply will continue to provide a trickle charge.

Split Supply

Frequently, "split power supplies" are required for amplifiers and other electronic circuits. The Model 1651 is ideally suited for "split power supply" operation. This supply can be configured to provide two positive voltages with a common negative, two negative voltages with a common positive, or one positive and one negative with a common ground. In addition, each of these configurations can be obtained with identical or differing voltages.

Two Identical Positive Voltages With A Common Negative

(Refer To Fig. 11)

Some electronic equipment requires two identical positive voltages with a common negative. A good example of this would be a digital car clock where there are two +12 volt inputs and a common negative. Using both supplies in the parallel tracking mode would provide the simplest hook-up and operation. This type of "split supply" operation is obtained as follows:

1. Select the **TRACKING PARALLEL** operating mode and set the **A/B Metering** to monitor the **"A"** supply.

2. Set the desired voltage and maximum current using the **"A" VOLTAGE** and **CURRENT** controls.

3. Connect a ground wire between the **"A"** supply's negative terminal and the **GND** (green) terminal.

4. Turn off the power supply and the equipment to be powered during hook-up.

5. Connect the positive polarity inputs of the circuit to be powered to the positive (red) terminals of the supplies and connect the common negative input of the circuit to be powered to the **"A"** supply's negative (black) terminal or the **GND** (green) terminal.

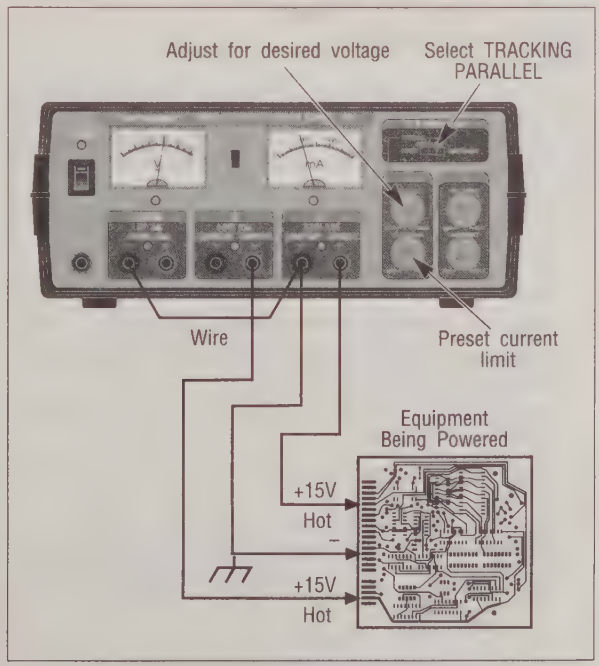

Figure 11. Typical hook-up using two identical positive voltages and a common negative.

Two Differing Positive Voltages With A Common Negative

(Refer To Fig. 12)

Many electronic circuits require two different positive voltages with a common negative. A typical example of this would be a device that uses both TTL (+5 V) and analog (typically +15 V) circuitry. Using both supplies, two differing positive voltages with a common negative are obtained as follows:

1. Select the **INDEPENDENT** operating mode and set the **A/B Metering** switch to monitor the **"A"** supply.
2. Set the desired voltage and maximum current for the **"A"** supply using the **"A" VOLTAGE** and **CURRENT** controls.
3. Set the **A/B Metering** switch to monitor the **"B"** supply.
4. Set the desired voltage and maximum current for the **"B"** supply using the **"B" VOLTAGE** and **CURRENT** controls.
5. Connect ground wires between each supply's negative terminal and the **GND** (green) terminal.
6. Turn off the power supply and the equipment to be powered during hook-up.
7. Connect the positive polarity inputs of the circuit to be powered to the positive (red) terminals of the supply. Connect the common negative input of the circuit to be powered to either of the supply's negative (black) terminals or the **GND** (green) terminal.

NOTE

The example in Fig. 12 uses the **"B"** supply to provide the +5V, so that current can be monitored on the **mA** meter. If the current requirments of the +5V circuits exceed 0.5A, then the **FIXED 5 V** output should be used.

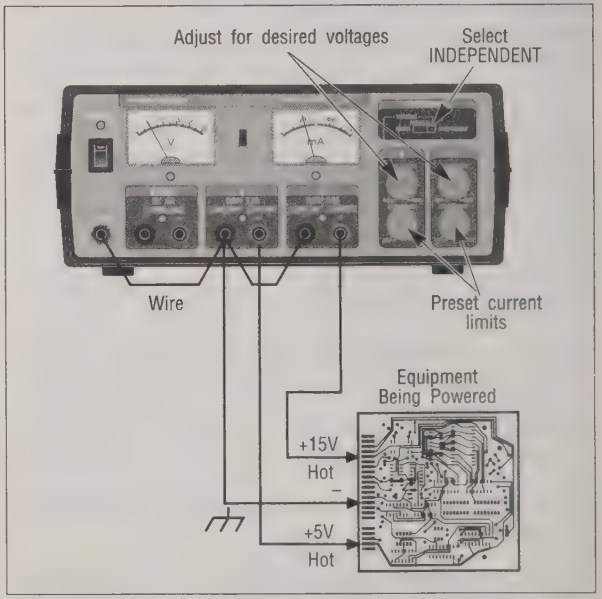

Figure 12. Typical hook-up using two differing positive voltages and a common negative.

Two Identical Negative Voltages With A Common Positive

(Refer To Fig. 13)

When the same negative voltage is required at two points in the same circuit and a common positive is needed, perform the following:

1. Select the **TRACKING PARALLEL** operating mode and set the **A/B Metering** switch to monitor the **"A"** supply.
2. Set the desired voltage and maximum current using the **"A" VOLTAGE** and **CURRENT** controls.
3. Connect a ground wire between the **"A"** supply positive terminal and the **GND** (green) terminal.
4. Turn off the power supply and the equipment to be powered during hook-up.
5. Connect the negative polarity inputs of the circuit to be powered to the negative (black) terminals of the supplies. Connect the common positive input of the circuit to be powered to either supply's positive (red) terminals or the **GND** (green) terminal.

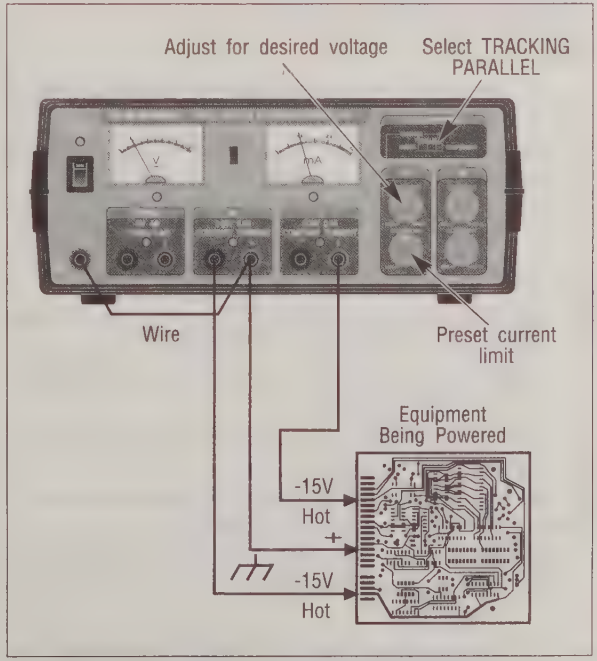

Figure 13. Typical hook-up using two identical negative voltages and a common positive.

Two Differing Negative Voltages With A Positive Common

(Refer To Fig. 14)

Using both supplies, two differing negative voltages with a common positive are obtained as follows:

1. Select the **INDEPENDENT** operating mode and set the **A/B Metering** switch to monitor the **"A"** supply.
2. Set the desired voltage and maximum current for the **"A"** supply using the **"A" VOLTAGE** and **CURRENT** controls.
3. Set the **A/B Metering** switch to monitor the **"B"** supply.
4. Set the desired voltage and maximum current for the **"B"** supply using the **"B" VOLTAGE** and **CURRENT** controls.
5. Connect ground wires between each supply's positive terminal and the **GND** (green) terminal.
6. Turn off the power supply and the equipment to be powered during hook-up.
7. Connect the negative polarity inputs of the circuit to be powered to the negative (black) terminals of the supplies.
8. Connect the common positive input of the circuit to be powered to either supply's positive (red) terminal or the **GND** (green) terminal.

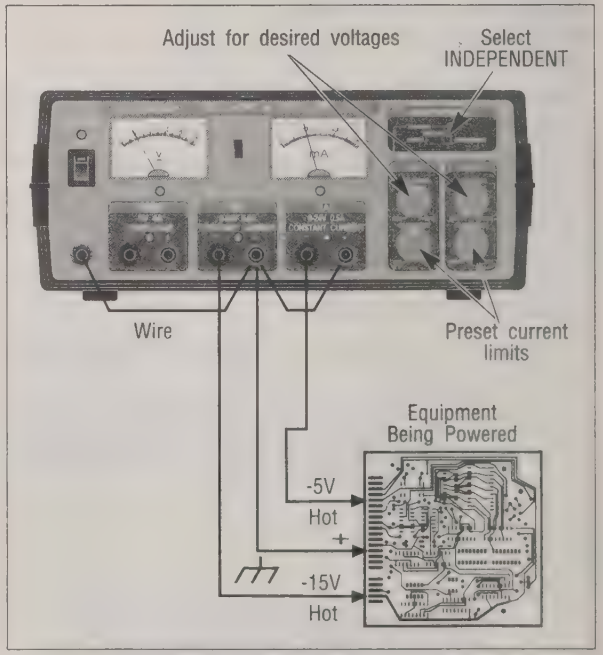

Figure 14. Typical hook-up using two different negative voltages and a common positive.

Identical Positive And Negative Voltages With A Separate Common

(Refer To Fig. 15)

Another typical "split supply" application is when a circuit uses operational amplifiers (op-amps). Typically, identical positive and negative voltages are required to power op-amp circuits. Using both supplies and the series tracking mode of operation, identical positive and negative voltages with a separate common are obtained as follows:

1. Select the **TRACKING SERIES** operating mode and set the **A/B Metering** switch to monitor the **"A"** supply.
2. Set the desired voltage using the **"A" VOLTAGE** controls.
3. Connect a ground wire between the **"A"** supply negative terminal and the **GND** (green) terminal.
4. Turn off the power supply and the equipment to be powered during hook-up.
5. Connect the positive polarity input of the circuit to be powered to the positive (red) terminal of the **"A"** supply and connect the negative polarity of the circuit to the negative terminal of the **"B"** supply. Connect the circuit ground to the negative terminal of the **"A"** supply, the positive terminal of the **"B"** supply, or the **GND** (green) terminal.

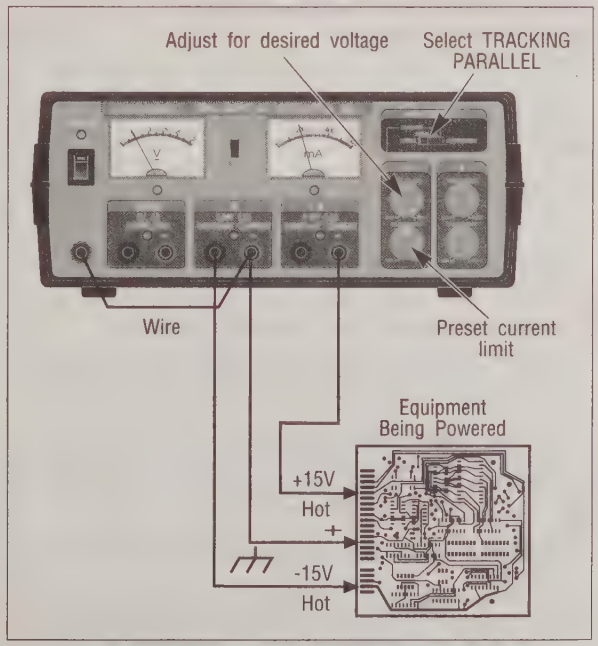

Figure 15. Typical hook-up using identical positive and negative voltages with a separate common.

Differing Positive And Negative Voltages With A Separate Common

(Refer To Fig. 16)

Using both supplies in the independent mode of operation, different positive and negative voltages with a separate common are obtained as follows:

1. Select the **INDEPENDENT** operating mode and set the **A/B Metering** switch to monitor the **"A"** supply.
2. Set the desired voltage and maximum current on the **"A"** supply using the **"A" VOLTAGE** and **CURRENT** controls.
3. Set the **A/B Metering** switch to monitor the **"B"** supply.
4. Set the desired voltage and maximum current on the **"B"** supply using the **"B" VOLTAGE** and **CURRENT** controls.
5. Connect one ground wire between the negative terminal of the **"A"** supply to the positive terminal of the **"B"** supply and another ground wire between the positive terminal of the **"B"** supply and the **GND** (green) terminal.
5. Turn off the power supply and the equipment to be powered during hook-up.
6. Connect the positive polarity input of the circuit to be powered to the positive (red) terminal of the **"A"** supply and connect the negative polarity of the circuit to the negative terminal of the **"B"** supply. Connect the circuit ground to the negative terminal of the **"A"** supply or the **GND** (green) terminal.

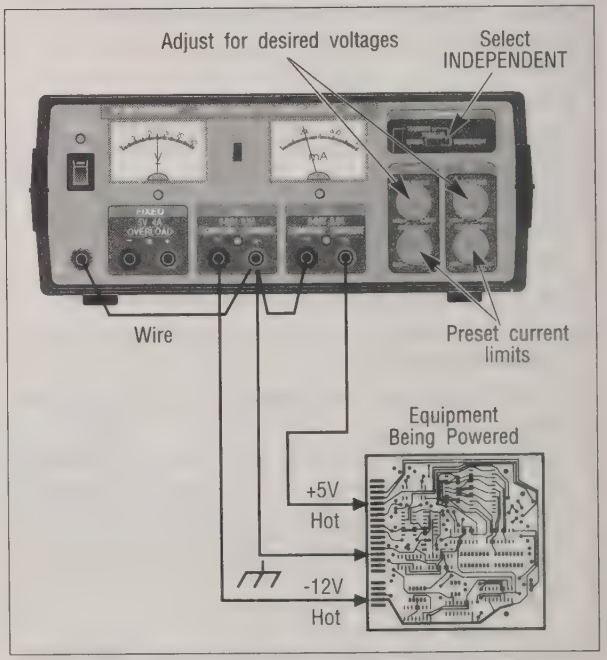

Figure 16. Typical hook-up using differing positive and negative voltages and a separate common.

WARNING

The following instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than contained in the operating instructions unless you are qualified to do so.

FUSE REPLACEMENT

If the fuse blows, the power on LED indicator will not light and the power supply will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse, then replace only with a fuse of the correct rating. For 110 or 120 V operation a 1.6 A, 250 V, 3AG fuse should be used and for 220 or 240 V operation a 0.75 A, 250 V, 3AG fuse should be used. The fuse is located on the rear panel (see Fig. 2).

LINE VOLTAGE CONVERSION

The primary winding of the power transformer is tapped to permit operation from 100, 120, 220, or 240 VAC, 50/60 Hz line voltage. Conversion from one line voltage to another is done by simply changing the LINE VOLTAGE SELECT switches located on the rear panel (see Fig. 2).

To convert to a different line voltage, perform the following procedure:

1. Make sure the power cord is unplugged.

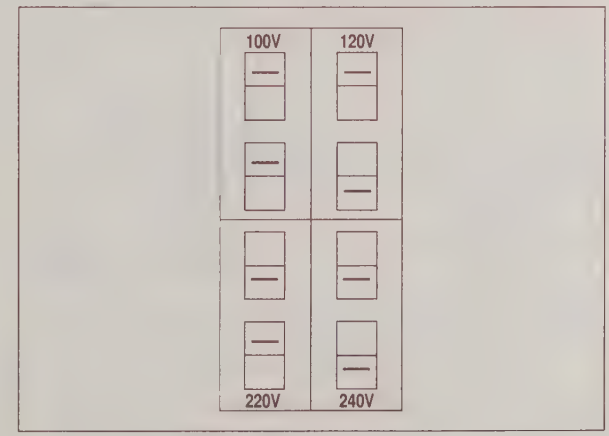

Figure 17. Line voltage conversion.

2. Reset the LINE VOLTAGE SELECT switches for the desired line voltage as shown on figure 17.

3. A change in line voltage may also require a corresponding change of fuse value. Install the correct fuse value as listed in the **FUSE REPLACEMENT** section.

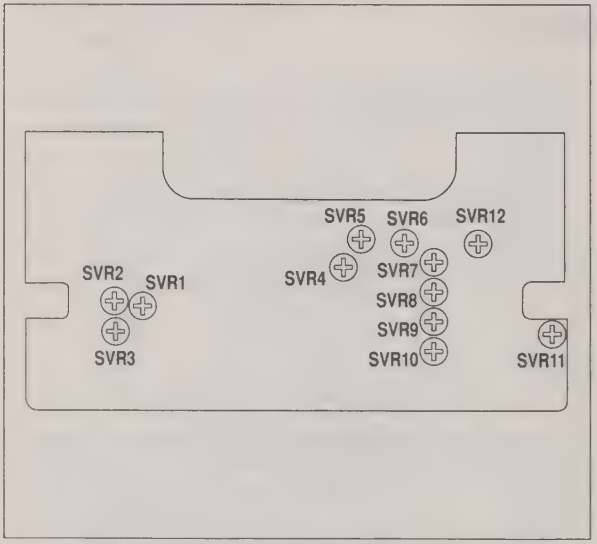

Figure 18A. Location of main board adjustments.

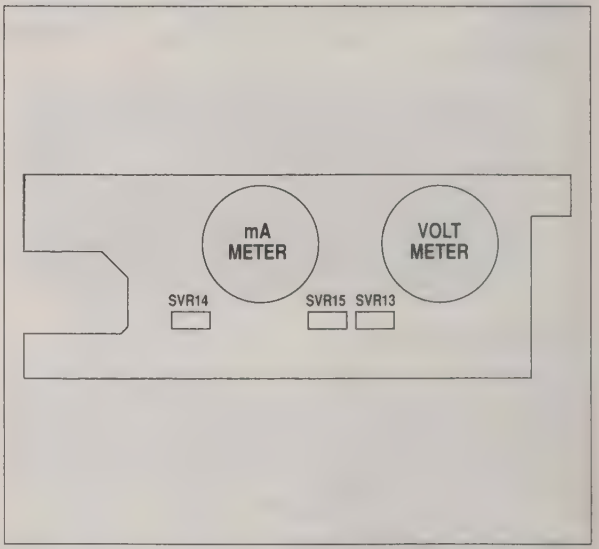

Figure 18B. Metering adjustments; control board solder side.

ADJUSTMENTS

This unit was accurately adjusted at the factory before shipment. Readjustment is recommended only if repairs have been made in a circuit affecting adjustment accuracy, or if you have a reason to believe the unit is out of adjustment. However, adjustments should be attempted only if two 3-1/2 digit multimeters with an accuracy of 0.5% dcV or better are available (**B & K-Precision** Model 388-HD or equivalent).

If readjustment is required, use the following procedure. All references to left and right are correct when facing the front of the supply. Locations of the electrical adjustments are shown in Fig. 18.

Meter Mechanical Zero Adjustments

The meters may be mechanically zeroed with a small slotted blade screwdriver thru the holes in the front panel (see Fig. 1) with the power turned off.

Table 1. Function of Adjustments

MAIN BOARD	
SVR1	FIXED 5V Current Foldback
SVR2	FIXED 5V OVERLOAD Indicator
SVR3	FIXED 5V Voltage
SVR4	A SUPPLY Max. Voltage
SVR5	A SUPPLY Max. Current
SVR6	A SUPPLY Min. Voltage
SVR7	B SUPPLY Max. Current
SVR8	B SUPPLY Max. Voltage
SVR9	B SUPPLY Min. Voltage
SVR10	Series Tracking Voltage
SVR11	Series Max. Current
SVR12	Parallel Max. Current
METERING BOARD	
SVR13	Volt Meter
SVR14	A SUPPLY **mA** Meter
SVR15	B SUPPLY **mA** Meter

Fixed 5 V Supply Adjustments

1. Connect one multimeter (set to 20 DCV Range) to measure the dc voltage across the **FIXED 5 V** supply output terminals.
2. Adjust trimmer potentiometer SVR3 located on the left side of the supply for a reading of 5.05 0.05 V on the multimeter.
3. Preset trimmer potentiometer SVR1 fully clockwise.
4. Connect a variable load (load must be rated to handle a power of at least 30 W) in series with a second multimeter (set to 20 DCA Range) to measure the dc output current across the **FIXED 5 V** supply output terminals.
5. Adjust the load so that the second multimeter shows an output current of 4.40 ± 0.10 A.
6. Adjust trimmer potentiometer SVR1 counterclockwise until the output voltage (read from first multimeter) drops by 0.05 to 0.20 V.
7. Turn trimmer potentiometer SVR2 fully counterclockwise.
8. Adjust trimmer potentiometer SVR2 clockwise until the **OVERLOAD** indicator first lights.

"A" Supply and A Metering Adjustments

1. Connect one multimeter (set to 20 DCV Range) to measure the dc output voltage across the **"A"** supply output terminals.
2. Set the **TRACKING/INDEPENDENT** mode switch to the **INDEPENDENT** (right) position and the **A/B Metering** switch to the A (up) position.

3. Set the **"A" VOLTAGE** control to minimum (fully counterclockwise).
4. Adjust trimmer potentiometer SVR6 for a reading of 0.00 ± 0.02 V on the multimeter.
5. Set the multimeter to 200 DCV Range.
6. Set the **"A" VOLTAGE** control to maximum (fully clockwise).
7. Adjust trimmer potentiometer SVR4 for a reading of 24.5 ± 0.2 V on the multimeter.
8. Set the **"A" VOLTAGE** control for a reading of 20.0 ± 0.1 V on the multimeter.
9. Adjust trimmer potentiometer SVR13 located on the METER BOARD so that the meter pointer on the Volts meter lines up with the 20 volt mark.
10. Set the **"A" CURRENT** control to maximum (fully clockwise).
11. Connect the second multimeter (set to 2 DCA Range) to measure the dc output current across the **"A"** supply output terminals.
12. Adjust trimmer potentiometer SVR5 for a reading of 0.550 ± 0.020 A on the second multimeter.
13. Set the **"A" CURRENT** control for a reading of 0.500 ± 0.010 A on the second multimeter.
14. Adjust trimmer potentiometer SVR14 located on the METER BOARD so that the meter pointer on the **mA** meter lines up with the 500 milliamp mark.

"B" Supply and B Metering Adjustments

1. Connect a multimeter (set to 20 DCV Range) to measure the dc voltage across the **"B"** supply output terminals.
2. Set the **TRACKING/INDEPENDENT** switch to the **INDEPENDENT** (right) position and the **A/B Metering** switch to the **B** (down) position.
3. Set the **"B" VOLTAGE** control to minimum (fully counterclockwise).
4. Adjust trimmer potentiometer SVR9 for a reading of 0.00 ± 0.02 V on the multimeter.
5. Set the multimeter to 200 DCV Range.
6. Set the **"B" VOLTAGE** control to maximum (fully clockwise).
7. Adjust trimmer potentiometer SVR8 for a reading of 24.5 ± 0.2 V on the multimeter.
8. Set the **"B" CURRENT** control to maximum (fully clockwise).
9. Connect a second multimeter (set to 2 DCA Range) to measure the dc output current across the **"B"** supply output terminals.
10. Adjust trimmer potentiometer SVR7 for a reading of 0.550 ± 0.020 A on the second multimeter.
11. Set the **"B" CURRENT** control for a reading of 0.500 ± 0.010 A on the second multimeter.

12. Adjust trimmer potentiometer SVR15 located on the METER BOARD so that the meter pointer on the **mA** meter lines up with the 500 milliamp mark.

"B" Tracking Adjustments

1. Set the supply to the **TRACKING SERIES** mode by setting the **TRACKING/INDEPENDENT** switch to the **SERIES** (left) position, and the **A/B Metering** switch to the **A** (up) position.

2. Set the **"B" VOLTAGE and CURRENT** controls to minimum (fully counterclockwise).

3. Set the **"A" VOLTAGE** control for a reading of 20 V on the 1651 front panel Volt Meter.

4. Connect the multimeter (set to 200 DCV Range) and measure the voltage across the **"A"** supply output terminals and note the EXACT voltage reading.

5. Disconnect the multimeter from the **"A"** supply outputs and connect it across the **"B"** supply outputs.

6. Adjust trimmer potentiometer SVR10 to obtain the exact same reading for the **"B"** supply output as was present at the **"A"** supply output in step 4.

7. Connect the multimeter (set to 2 DCA Range) to measure the dc output current across the **"A"** supply positive output terminal and the **"B"** supply negative terminal.

8. Set the **"A" CURRENT** control to maximum (fully clockwise).

9. Adjust trimmer potentiometer SVR11 for a reading of 0.550 ± 0.010 A on the multimeter.

10. Set the supply to the **TRACKING PARALLEL** mode by setting the **TRACKING/INDEPENDENT** switch to the **PARALLEL** (middle) position.

11. Connect the multimeter (set to 2 DCA Range) to measure the current between the output terminals of the **"A"** supply.

12. Adjust trimmer potentiometer SVR12 for a reading of 1.100 ± 0.020 A on the multimeter.

INSTRUMENT REPAIR SERVICE

Because of the specialized skills and test equipment required for instrument repair and calibration, many customers prefer to rely upon **B & K-Precision** for this service. We maintain a network of **B & K-Precision** authorized service agencies for this purpose. To use this service, even if the instrument is no longer under warranty, follow the instructions given in the **WARRANTY SERVICE INSTRUCTIONS** section of this manual. There is a nominal charge for instruments out of warranty.

WARRANTY SERVICE INSTRUCTIONS
(For U.S.A. and its Overseas Territories)

1. Refer to the MAINTENANCE section of your **B & K-Precision** instruction manual for adjustments that may be applicable.
2. If the above-mentioned does not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed).
3. Enclose a letter describing the problem and include your name and address.
4. Enclose proof of purchase date; that is, a dated copy of the sales receipt.
5. Deliver to, or ship PREPAID (UPS preferred in U.S.A.) to the nearest **B & K-Precision** authorized service agency (see list enclosed with unit).

If your list of authorized **B & K-Precision** service agencies has been misplaced, contact your distributor for the name of your nearest service agency, or write to:

B & K-Precision, MAXTEC INTERNATIONAL CORP.
Factory Service Operations
6470 West Cortland Street
Chicago, Illinois 60635
Tel (312) 889-1448
Telex: 25-3475

Also use this address for technical inquiries
and replacement parts orders.

LIMITED ONE-YEAR WARRANTY

MAXTEC INTERNATIONAL CORP. warrants to the original purchaser that its **B & K-Precision** product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

MAXTEC will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized **B & K-Precision** service contractor or the factory service department, accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty registration card to **MAXTEC, B & K-Precision**, 6470 West Cortland Street, Chicago, Illinois 60635 within fifteen (15) days from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

MAXTEC shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your **B & K-Precision** distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to **B & K-Precision** Service Department, 6470 West Cortland Street, Chicago, Illinois 60635, properly packaged to avoid damage in shipment.

B & K-Precision Test Instruments warrants products sold only in the U.S.A. and its overseas territories. In other countries, each distributor warrants the **B & K-Precision** products which it sells.

NOTES

TEST INSTRUMENT SAFETY

(continued from inside front cover)

4. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.

5. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet.

6. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.

7. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.

8. Some equipment with a two-wire ac power cord, including some with polarized power plugs, is the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic or wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test instruments or the equipment under test may result from connecting an earth ground lead of a test instrument to a "hot chassis". To make measurements in "hot chassis" equipment, always connect an isolation transformer between the ac outlet and the equipment under test. The **B & K-Precision** Model TR-110 or 1604 Isolation Transformer, or Model 1653 or 1655 AC Power Supply is suitable for most applications. To be on the safe side, treat all two-wire ac powered equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.

9. **B & K-Precision** products are not authorized for use in any application involving direct contact between our product and the human body, or for use as a critical component in a life support device or system. Here, "direct contact" refers to any connection from or to our equipment via any cabling or switching means. A "critical component" is any component of a life support device or system whose failure to perform can be reasonably expected to cause failure of that device or system, or to affect its safety or effectiveness.

10. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

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